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confess ignorance, which is after all what the whole proceeding plainly shows.

Plate IV furnishes a very striking and interesting illustration of head-markings, with arrows arranged to show how one form of marking may have been derived from another, and how all may be reduced to five general types. As, however, the birds representing the successive stages of modification belong usually to distantly related genera, or even families, and as the relationships, as our author says in the text (p. 187) "are not supposed to be genetic," it may be asked, Of what practical utility is this elaborate generalization? Or what light does it throw upon the real method of evolution of these various patterns?

Great stress is laid upon the "primitive streaked plumage," and upon the streaked feather as a primitive type. While this may be true in a restricted sense, and form a test of grade in a group of closely allied species, it fails when taken in a general sense, as for instance in comparing Pigeons and Tinamous (genus *Tinamus*) as groups with Thrushes and Sparrows, or many 'low' groups with higher ones.

While Mr. Keeler's book is highly original in both conception and execution, and exceedingly novel and interesting in its pictorial illustrations, it displays, we are pained to say, much misdirected energy; and unless the lay reader and the novice keep in mind the opening paragraph of the preface, they are liable to acquire a large amount of misinformation,—
J. A. A.

Beddard's 'Animal Coloration.'¹—The present volume, says the author, is addressed to persons having no special knowledge of zoölogy, and its aim is "to furnish a general notion of the facts and theories relating to Animal Coloration." "It contains hardly anything novel, but professes to give some account of the principal phenomena of coloration exhibited by animals." It is thus mainly a review of previous theories and the facts on which they are based, with a running critical commentary representing the views of the author respecting the many disputed points at issue. It consists of six chapters, having the following headings: I. 'Introductory.—The Principal Facts of Animal Coloration' (pp. 1-41); II. 'Coloration affected by the Environment' (pp. 42-82); III. 'Protective Coloration' (pp. 83-147); IV. 'Warning Coloration' (pp. 148-192); V. 'Protective Mimicry' (pp. 193-252); VI. 'Sexual Coloration' (pp. 253-282).

Mr. Beddard distinguishes 'Colour' from 'Coloration,' the former relating to the actual tints, the latter to the arrangement or pattern of these tints. Colors are due either solely to the presence of definite pigments,

¹ Animal Coloration | an Account of | The Principal Facts and Theories | relating to the | Colors and Markings of Animals. | By | Frank E. Beddard, M. A. Oxon., F. R. S. E., etc., | Prosecutor to the Zoological Society of London, Lecturer on Biology at Guy's Hospital | With Four Colored Plates; and Woodcuts in the Text | [Monogram] London: Swan, Sonnenschein & Co. | New York: Macmillan & Co. | 1892. —8vo, pp. viii, 288.

or in part to optical effects, due to mechanical structure, as in the case of iridescent feathers, scales, etc., by which the light rays are scattered, diffracted, or unequally refracted; in such cases, however, a background of dark pigment is necessary for the display of the metallic lustre. A variety of pigments has been found and chemically analysed, by which it is found that the same color, even in allied forms, is not always due to the same pigment. "The brown colour of birds is chiefly due not to one pigment, but to two apparently distinct pigments, which give different chemical reactions." The green color of the Turacou is due to an entirely different pigment from that which causes the green color in Parrots. Thus the same effect is often produced by quite different pigments. Again, differently colored animals have the same pigment, as in the case of the very differently colored sexes in the Parrots of the genus *Eclectus*, the color difference being due to a difference in the structure of the feathers, the males in these Parrots being colored green and the females red.

Color is believed to be "a normal product of organization, entirely independent of utility"; yet there is good evidence that "'coloration' bears often a distinct relation to the needs of the animal," and may therefore be modified by 'natural selection,' using this term in its broadest sense. On the other hand, it is quite evident that coloration is not always in harmony with the mode of life of the animal, while often 'complex markings' are so placed as to be of no possible use to the animal possessing them. It is hence frequently impossible to advance any reasonable hypothesis to account for their presence. Hence Mr. Beddard freely admits that the "action of natural selection" in producing color changes is limited. He also calls attention to the comparative constancy of color and color markings throughout whole genera and even families, and also that the same plan of coloration is often repeated in very distantly related groups. This fact is sometimes explained on the ground of mimicry, but in many cases such an explanation is beyond supposition.

In some instances there is apparently some relation between coloration and structure of the underlying parts of the organism, but the cases where this is obvious, or where some better explanation may not be suggested, are very few: the agreement is, we believe, more a matter of chance coincidence than one of any deeper relation.

In discussing changes of color during the lifetime of the individual, Mr. Beddard points out various flaws in the reasoning of Weismann and Poulton on the subject, but leaves much unsaid that may be urged in opposition to their views. Lack of space, however, forbids entering upon the subject in this connection.

Mr. Beddard, we are glad to see, is willing to grant that the influence of an animal's surroundings may exercise a direct influence upon its coloration without the intervention of the agency of 'natural selection.' Under this head are very properly considered the seasonal changes of many Arctic animals.

The subject of 'Protective Coloration' is discussed at considerable length, and for the most part with commendable conservatism, in comparison with the credulous spirit in which the subject is often handled. Many previously alleged cases of protective coloration are considered as not proven, or as *sub judice*, or as more satisfactorily explainable in other ways. Furthermore, he does not consider that protective resemblances between animals and their surroundings have all been produced by natural selection, citing many instances in which the assimilation of color to the natural surroundings is pretty obviously due to food,—as notably among the various marine animals which feed upon the brightly colored sea weeds among which they live. He says (p. 132): "Considering the resistant nature of many pigmentary substances, vegetable as well as animal, it is at least probable that a large number of cases of color resemblance, often set down to the action of natural selection, may be due, as in the case of *Eunice*, to the simple excretion by the skin of these pigments which have been taken in as food. Until more is known about the chemical composition of animal pigments, *it would be rash to adopt an elaborate explanation when the more simple one would be sufficient.*" If the course recommended in the passage we have italicised in the above quotation were generally followed in similar cases, much worthless speculation would be saved, greatly to the advantage of real scientific progress. Again Mr. Beddard observes: "At every step, in fact, in the study of animal coloration, we are met with closed doors, which can only be unlocked by keys furnished by an intimate chemical and physiological knowledge such as we do not at present possess" (p. 140).

The subject of 'Warning Colors' is discussed at considerable length and with great candor. Here Mr. Beddard's remark that "The field of hypotheses has no limits," and that what we need is "more study," applies with special force. After reviewing the evidence, pro and con, he appears to arrive at the conclusion that 'warning colors,' particularly in insects and the lower forms of life generally, have not been evolved for the express purpose of warning, but rather that they are concomitant with inedibility—"that the brilliant colors (*i. e.*, the abundant secretion of pigment) have caused the inedibility of the species, rather than that the inedibility has necessitated the production of bright color as an advertisement" (p. 173). The theory of warning colors is, of course, that they have been especially evolved to give notice of some disagreeable quality. The skunk (genus *Mephitis*) has come to be a classic illustration of the theory. But Mr. Beddard points out that in South America skunks are not free from enemies, being the prey, and sometimes the chief food, of many rapacious birds; and those readers of 'The Auk' who have had much acquaintance with our Great Horned Owl can give corroborative testimony in respect to those of North America.

Closely related to the theory of 'warning colors' is that of 'Protective Mimicry,' to which it is supposed to furnish support. This theory origi-

nated with Mr. H. W. Bates, the well-known English naturalist who spent so many years on the Amazon in South America. It was suggested by his finding that a certain group of butterflies (*Heliconidæ*), conspicuously banded with yellow and black, were provided with certain glands which secrete a nauseating fluid, supposed to render them unpalatable to birds. In the same situations were also found similarly colored butterflies belonging to another family (*Pieridæ*), which so closely resembled the others in shape and markings as to be easily mistaken for them, but which were unprovided with the scent-secreting glands, and were thus unprotected from attacks from birds. This resemblance it was thought was brought about by natural selection for the protection of the edible butterflies through the birds mistaking them for the inedible kind. Other cases of mimicry among a great variety of insects have since been pointed out, and the theory of protective mimicry has secured many adherents. A close scrutiny of these alleged cases, however, shows that in many instances, and to a considerable extent, 'protection fails to protect.' Mr. Beddard gives the evidence in favor of mimicry at some length, interspersed with some rebutting comment, and then discusses the objections to the theory. The discussion is too long to be followed here, and the objections too numerous even for recapitulation. One is that resemblances occur between animals inhabiting widely separated areas which are so close that if the same forms were found together one would be considered as a case of mimicry of the other. Again resemblances occur between distantly related forms found in the same country in which neither has any special means of protection, and hence the 'mimicry' is without any protective effect. Again, cases occur where the resemblance is a positive disadvantage to the mimicker. Many special cases, as of flies mimicking bees, spiders mimicking ants, etc., are dealt with separately, and the objections in each case seem fairly conclusive. In commenting upon the rarity of even alleged cases of mimicry among mammals, Mr. Beddard considers that this fact is not remarkable, when we consider how few the total number of mammals is when compared with insects, and that out of the vast assemblage of the latter "it would be strange if there were not many cases of accidental resemblance; and there are many such" (p. 237).

In 'Chapter VI. Sexual Coloration,' Mr. Beddard appears to wholly reject Mr. Darwin's much admired theory of 'Sexual Selection,' and quotes at length Mr. Wallace's *reductio ad absurdum*, which, as illustrating the view of an ultra natural selectionist, may well be here transcribed: "Natural selection . . . acts perpetually and on an enormous scale in weeding out the 'unfit' at every stage of existence, and preserving only those which are in all respects the very best. . . . Now this extremely rigid action of natural selection must render any attempt to select mere ornament utterly nugatory, unless the most ornamented always coincide with 'the fittest' in every other respect; while if they do so coincide, then any selection of ornament is altogether superfluous. If the most brightly coloured and fullest plumaged males are *not* the most healthy and vig-

orous, have *not* the best instincts for the proper construction and concealment of the nest, and for the care and protection of the young, they are certainly not the fittest, and will not survive, or be the parents of survivors. If, on the other hand, there *is* generally this correlation — if, as has been here argued, ornament is the natural product and direct outcome of superabundant health and vigour, then no other mode of selection is needed to account for the presence of such ornament. The action of natural selection does not indeed disprove the existence of female selection of ornament as ornament, but it renders it entirely ineffective; and as the direct evidence for any such female selection is almost *nil*, while the objections to it are certainly weighty, there can be no longer any reason for upholding a theory which was provisionally useful in calling attention to a most curious and suggestive body of facts, but which is now no longer tenable.”¹

Mr. Beddard adds: “In short, we find that the secondary sexual characters of animals are dependent upon the germ glands themselves; and that the sexual diversity of animals is also associated with differences of disposition and habit. There is a fundamental difference between males and females, based upon the actual difference of sex, which generally finds an expression in outward unlikeness. These superficial differences may also be partly due to the different mode of life led by the two sexes. We meet with them in animals which cannot be moved by choice or æsthetic preference; but it is also true that they are most highly developed in the higher animals, where such choice is at least conceivable; the mammal, however, forms a very important exception to this statement” (p. 282).

A fine vein of irony occasionally appears in Mr. Beddard’s comments upon alleged cases of mimicry, and especially of alleged instances of sexual selection, as in respect to the mating and ‘love dances’ of spiders. But on the whole his criticisms are suggestive rather than aggressive.

We have long been of the opinion that most of the cases of supposed ‘warning colors,’ of mimicry, and sexual selection were to be much more satisfactorily accounted for on other grounds than by the special theories that have of late proved so popular with superficial writers, and apparently so fascinating to the still less discerning public, and we are glad to welcome so healthy an antidote to this mild phase of scientific lunacy as Mr. Beddard’s book on ‘Animal Coloration.’ — J. A. A.

Our Hawks and Owls in their Relation to Agriculture. — ‘Bulletin No. 3’ of the Ornithological Division of the U. S. Department of Agriculture,²

¹ Wallace, *Darwinism*, p. 295.

² The Hawks and Owls of the United States in their Relation to Agriculture. Prepared under the Direction of Dr. C. Hart Merriam, Ornithologist, by A. K. Fisher M.D., Assistant Ornithologist. Published by Authority of the Secretary of Agriculture. Washington: Government Printing Office, 1893.—8vo, pp. 220, with 26 colored plates = U. S. Department of Agriculture, Division of Ornithology and Mammalogy, Bulletin No. 3.